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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

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Date of mailing (day/month/year) 07 February 2000 (07.02.00)	
International application No. PCT/GB99/01964	**Applicant's or agent's file reference** NJE/G04380PC
International filing date (day/month/year) 22 June 1999 (22.06.99)	**Priority date** (day/month/year) 22 June 1998 (22.06.98)
Applicant POWELL, George, Leonard	

1. The designated Office is hereby notified of its election made:

   [X] in the demand filed with the International Preliminary Examining Authority on:

   16 December 1999 (16.12.99)

   [ ] in a notice effecting later election filed with the International Bureau on:

2. The election   [X] was

   [ ] was not

   made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

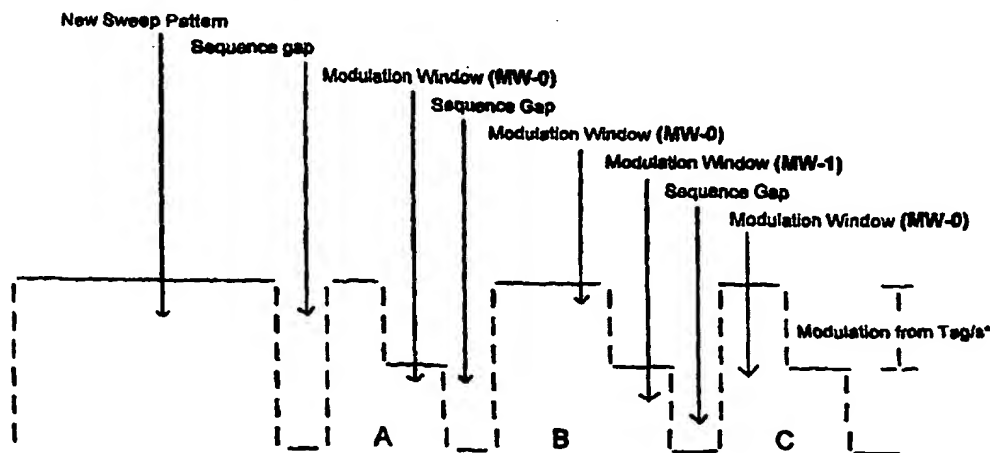|	
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	**Authorized officer** Olivia RANAIVOJAONA
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Form PCT/IB/331 (July 1992)   3090509

(54) Title: ANTI-COLLISION TAG APPARATUS AND SYSTEM

*Note. The amount of modulation from tags is exaggerated. Typical modulation may be too small to be shown.

(57) Abstract

This invention relates to radio frequency identification (RFID) apparatus comprising a reader/writer and transponders (tags) such that 2 or more transponders are capable of operating simultaneously in the same field so that information in the form of data bits may be received from or sent to the tags without corruption.

ANTI-COLLISION TAG APPARATUS AND SYSTEM

The present invention relates to radio frequency identification (RFID) apparatus comprising

5 a reader/writer (later referred to as a 'reader') and transponders (tags).

Such apparatus forms the basis of a radio frequency tagging system, where the number of

tags within the field that may be read is limited only by the number of unique combinations

of bits used to define a code to identify each tag. Alternatively, two or more tags may define

10 a set with the same combination or part combination of bits and these may be selected

simultaneously. Such may be the case when deliberately sending data to tags of the same

combination or part combination for the purposes of writing to them or disabling them or

otherwise addressing them to modify their functionality.

15 In operation, an RFID reader will attempt to communicate with one or more RFID tags

within the reader's transmission area. The reader transmits a predetermined signal (hereafter

referred to as a "field") and then monitors the signal. The tags responding to the signal

modulate it in a predetermined manner which is identified by the reader. However, if there

are a number of tags within the transmission area it is difficult and time consuming to

20 identify individual tags, communicate with only one tag and even to decrypt their responses

to the transmitted signal.

Previous systems have mostly tried to achieve anti-collision of the signals modulated by the

tags by incorporating some means to 'talk' to single tags, for example, by binary selection,

25 sometimes by using randomness and helped by the slightly differing times that the tags are

introduced into the area, or by beaming (directional control) of the field or by modification

of the field or alternatively by use of complicated algorithms to decrypt overlay data.

These systems are typically hindered by more than one tag 'talking' at the same time.

5   In the past systems have attempted to decrypt overlaying data caused by multiple tags 'talking' at the same time or have relied on random transmissions to separate signals in the time domain or have used a field beam or conduct a time consuming binary search to isolate individual tags. Often tags need to be read twice or even 3 times to confirm there has been no data error.

10

According to an aspect of the invention, there is provided a radio frequency tag apparatus comprising a plurality of tags and a transceiver for sending information to and receiveing information from the tags, wherein each tag is allocated an identification word comprising a predetermined number of bits, the tags comprising means for selectively modulating a 15   signal received from the transceiver, and the transceiver comprising means for sending an interrogation signal comprising a plurality of portions, wherein each portion is associated with a predetermined bit, or bit sequence, of the identification words and is used to interrogate, substantially at the same time, the tags to identify, in response to modulated signals provided by the tags, the presence of a tag or tags having a given value at the 20   predetermined bit or bit sequence.

According to another aspect of the present invention, there is provided a method of detecting the presence of tags within a target area by sending interrogation signals from a transceiver for selective modulation by tags present in the target area, each tag being allocated an

identification word comprising a predetermined number of bits, the method comprising:

sending from a transceiver an interrogation signal comprising a plurality of portions, each portion being associated with a predetermined bit or bit sequence of the identification words and being capable of conveying a given value for the bit or sequence of bits, wherein tags having the value at the predetermined bit or bit sequence are configured to modulate the signal, the modulation being used to identify the presence of those tags.

According to a further aspect of the present invention, there is provided a radio frequency tag identification system comprising a receiver/transmitter and transponders which are adapted to start communication at the same time and to be simultaneously interrogated and progressively eliminated from interrogation.

The present invention is directed to an alternative way of interactively isolating tags in a way that is highly efficient and very fast.

Operation is such that two or more transponders are capable of operating simultaneously in the same field in such a manner that information in the form of data bits may be received or sent to the tags without corruption. This has come to be known as anti-collision.

In contrast to previous systems, the present invention will not work unless the tags are allowed to 'talk' at the same time and uses positively 'collision' rather than trying to avoid it.

Moreover, the system of the present invention described is self-checking. Not only does the

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reader check the tag output but the tag also checks the reader output. and will drop out in the case of an error. This self check means the tag need only be read once and is secure.

The invention will now be described by way of example only, with reference to accompanying figures:

Figure 1 is a data bit stream for use in an apparastus in accordance with the invention;

Figure 2 is another data bit stream for use in an apparatus in accordance with the invention;

Figure 3 is another data bit stream for use in an apparatus in accordance with the invention;

Figure 4 is a block diagram of an RFID 'reader' for use in an apparatus in accordance with the invention; and

Figure 5 is a block diagram of an RFID 'tag' for use in an apparatus in accordance with the invention.

In an embodiment of the invention all active tags are requested to start communicating at the same time, forming a 'collision' and are simultaneously interrogated and progressively eliminated. Communications from the tags are synchronised by, in this case, a search pattern, but this may be by any other form of synchronisation. Tags that do not receive a valid search pattern do not send data at all.

The invention might be better thought of as Synchronised Collision. It is normal for a reader to communicate to the tag using 100% modulation of the field. To start a search pattern, the reader transmits a data pattern called a 'Start Search Pattern'. This is understood by all tags as a start search command. There is another pattern known as a 'New Sweep Pattern' which

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signals a new sweep within the overall search. Each sweep represents a single interrogation of the tags winthin reach and a number of sweeps equal to the number of tags plus one are needed to identify the presence of each individual tag. A search will generally consist of as many sweeps as there are tags in the field and an additional final sweep that may be aborted when no tags respond. The above "start search" and "new sweep" patterns in this example are detected by their duration but may be any compatible distinguishable pattern.

Tags are only allowed to participate in a search if they have received a 'Start Search Pattern'. This among other things, prevents late arrivals from disrupting the search. After the valid reception of a start search pattern, the tag is said to go active. The reader next transmits the interrogation pulse sequence. In this embodiment, the length of the pulse determines the binary value of the interrogation pulse, but alternative encoding schemes such as pulse code modulation may be used. The tag employs amplitude modulation, however, alternative methods such as phase shift keying may be used.

A 'search' will consist of a number of 'sweeps'. Each sweep will select an individual tag or set of tags sharing the same address. A normal sequence of a search of tags of different addresses will be shown below. Three states are referred to. These are 'Active' in which case the tag will participate in the search. 'Quiescent' in which case the tag is waiting for another sweep, and 'Inactive' in which case the tag has either not received a 'Start New Search' pattern or has already participated in a search and been eliminated (wrtten to and/or read).

The sequence of steps for identifying tags in a field is as follows;

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(a) A 'Start Search Pattern' is transmitted by the reader to alert all tags in the field that a search is to follow:- all tags in range go 'active'.

(b) A sequence of interrogation pulses (portions) corresponding to the number of bits, or sequences of bits, of the tag identification word, or else a reduced number if a set is to be identified, is sent out by the reader to which active tags interactively respond and all but 1 tag (or a set of tags sharing an identical address) is eventually eliminated. Data may be written to any tag/tags selected. Any tag so selected will then go inactive until the next 'Start Search Pattern'. Tags failing to be selected on a bit by bit (or bit pattern by bit pattern) basis go quiescent the moment they fail such an interrogation.

(c) A 'New Sweep Pattern' is transmitted by the reader – all tags in the quiescent state go active again. Tags that have not received a 'Start Search Pattern' or have already been selected (read) remain inactive.

(d) The reader loops back to 'b' above. At n +1 loops the reader detects no further tag interaction and ends the current search.

After transmission of a 'Start Search Pattern' the reader sends out a pulse. As the pulse duration increases, it passes through a period in time named the 0 modulation window (MW-0) in which all active tags which have a 0 in the first bit position must reply by turning on their modulator thus modulating the field. In the absence of a detectable response the reader will continue the duration of the pulse. As the pulse duration increases it passes through another period named the 1 modulation window (MW-1) in which all active tags which have a 1 in the first bit position must reply by turning on their modulator thus modulating the field. (Later it will be explained how bit patterns (such as 00,01,10,11) can be substituted for the individual bits.)

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An example of a start search pattern followed by the transmission of three MW-0 windows, as transmitted by a reader, is shown in Figure 1.

In this embodiment, a tag will always be asked if its next bit is a 0 before it is asked if its next bit is a 1. Where more than one tag replies by modulating the field at the same time, the modulation of the field is increased. Logic within the reader will normally, upon the detection of modulation appearing in a MW-0 window, not extend the pulse to transmit a MW-1 modulation window. Where the MW-1 modulation window is not transmitted, any active tag that has a 1 in that position is programmed to go quiescent until a 'New Sweep Pattern' is received. In the instance that no active tag has a '0' in this position, the reader will extend the pulse up to the '1' position and all the active tags with a '1' in this position will remain active. The gap between the reader pulses is used by the tag to sequence the progress through the bits. The reader transmits the next interrogation pulse and so on. In this way the reader can conduct a highly efficient binary elimination, such that it needs only a 'Start Search Pattern' or a 'New Search Pattern' followed by as many pulses as there are bits in the tag type.

In this embodiment no distinction is made between tag data and the tag address. Tag data, if present, may be placed at the end of a tag address or alternatively in addressable blocks. Once a single tag has been isolated, the same process could be repeated to read any tag data, if present, however once the possibility of collisions has been eliminated, tag data can then be read in a more conventional way such as Manchester encoding or Phase shift modulation. The key point in this invention is the self checking 'anti-collision' method of isolating a single tag (or set of tags of the same address or part address) by the method described.

A tag may receive a start search pattern or a new sweep pattern and participate yet be out of the read range of the reader. In this instance the tag itself detects an apparent inconsistency in the reader transmissions. For example a tag which has just modulated a 0 window will expect the pulse to terminate instead of going on to the 1 modulation window. In this case the tag will go quiescent and wait for a new sweep pattern. This is a self-check and is a system advantage.

When a single tag or set of tags has been successfully isolated and identified, the reader may also write data to it (assuming the tag has EEROM or EPROM). Once read, the tag may be pre-programmed to remain silent until either the field is removed or it receives a new 'Start Search Pattern'. The reader will usually next transmit a 'New Sweep Pattern' and continue reading and eliminating tags until none remain. The 'New Sweep Pattern' wakes any tag in the 'quiescent state' that has been eliminated, but not read, from a previous sweep, allowing it to participate in the next sweep. Each sweep will normally identify a unique tag hence there will usually be as many sweeps as there are tags in the field, and a last sweep that will produce no results and may be aborted early.

The reader begins by sending a search pattern. The reader next starts to transmit a pulse. If no tag modulates the 0 window of the pulse, the reader will deduce that there is no active tag in the field that has a 0 in the first bit position. In this case the reader would continue the pulse to include a 1 modulation window. Any tag in the field with a 1 in this position will start modulating in this window and will continue to be active. In the instance of the first bit, if neither window is modulated the reader will deduce that there is no tag in range.

Assuming the first bit is modulated in the 0 modulation window (MW-0) and the reader

stopped the pulse before the 1 modulation window, any tag with a 1 in this position will go

quiescent until either a 'New Sweep Pattern' or a 'Start Search Pattern' is received. The

reader continues onto the second bit and so on until it gets to the last bit position and an

5   individual tag (or set of tags) has been isolated. After a tag has been identified and eliminated

the reader will start a new sweep. (The significance of mentioning a 'set of tags' lay in the

possibility that a special set of tags can be switched off, or if the facility allows, be written

to, or otherwise made to perform in a special way. A further type of reader modulation may

be inserted – say by a pulse extending beyond the 1 modulation window or an extra mini

10   pulse - to let the set know it has been selected.)

In this fashion the reader will detect a 64 bit tag every 64 bit pulses (not including the 'Start

Search Pattern and the 'New Sweep Patterns'). This is a highly efficient algorithm.

15   Figures 2 and 3 show a received signal at the reader, in response to a signal transmitted by

the reader and modulated by tags.

Referring to Figure 2, it will be seen that pulses A, B and C have all been modulated in the

'0' modulation window (MW-0). This is represented by the fall in the signal level following

20   the MW-0 signal. This shows that there is at least one active tag in the field having a '0' in

the first three bit positions. The 'Start Search Pattern in fig 1 is shown as a long pulse by

example. In practice a long break in the field is more usual. This resets all tags.

In Figure 3, it will be seen that the first pulse (A) has been modulated by at least one tag

which has a '0' in the first position. The second interrogating pulse (B) shows that no active

tags have a '0' bit in this position. As a consequence the reader has continued the pulse to

allow active tags with a '1' in this position to respond and modulate the '1' modulation

window and stay active. In this way tags are progressively read and eliminated.

5   In this embodiment modulation of the field by the tags is amplitude modulated (ASK) but

phase modulation (PSK), frequency modulation (FSK) or any detectable form of modulation

may be employed.

In this embodiment individual bits have been interrogated for simplicity, although   bit

10   patterns can be interrogated such as 00, 01, 10 or 11 and so on. In the instance of the

following bit patterns, 00,01,10,11 this can be achieved by using 4 possible modulation

windows representing the 4 possible combinations. The operation will be then carried out as

before. The first modulation window could be 00. Any active tags having this bit pattern at

this stage of the prosecution of the interrogation will be required to modulate this window

15   and remain active. This will eliminate tags having bit patterns 01,10 and 11. Should no tags

have a 00 pattern then the reader will extend the pulse to include the next modulation window

and so on as in the case of detecting '0' and '1' bits. Because the reader need not modulate

the field as many times, there is some speed advantage. As the bit pattern is increased

beyond 2-3 bits it will be increasingly more difficult extract a speed advantage and if the bit

20   pattern is made still larger the overall speed will eventually diminish.

Figures 4 and 5 are block diagrams of conventional apparatus configured for use in the

present invention.

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Claims

1. A radio frequency tag apparatus comprising a plurality of tags and a transceiver for sending information to and receiveing information from the tags, wherein each tag is allocated an identification word comprising a predetermined number of bits, the tags comprising means for selectively modulating a signal received from the transceiver, and the transceiver comprising means for sending an interrogation signal comprising a plurality of portions, wherein each portion is associated with a predetermined bit, or bit sequence, of the identification words and is used to interrogate, substantially at the same time, the tags to identify, in response to modulated signals provided by the tags, the presence of a tag or tags having a given value at the predetermined bit or bit sequence.

2. An apparatus as claimed in claim 1, further comprising, an antennae array, a radio frequency transponder, an external data communication port and an energising source.

3. An apparatus as claimed in 1 or 2 capable of generating modulated radio frequency power for application to the antennae.

4. An apparatus as claimed in any one of the preceding claims, including in each tag an inductive loop antennae or capacitor plates that will convert the electric power into an electric field to communicate with transponders and in some cases provide the power for transponders where this power is not derived internally within the transponder from internal batteries or a light cell.

5. An apparatus as claimed in any one of the preceding claims, including in each tag an antenna that will convert the signal power from the transceiver into an RF field to communicate with transponders.

6. An apparatus as claimed in any one of the preceding claims, including means for determining the nature of the modulation based on the logical outcome of previous communications with tags to conduct a binary search.

7. An apparatus as claimed in any one of the preceding claims, including means for detecting the modulation impressed on the field by any tag comprising a demodulator and an amplifier, wherein the modulation signal is sent to a processor in a logic block and is digitised within a logic processor and evaluated.

8. An apparatus as claimed in any one of the preceding claims, the tag or tags comprising of signal pickup means, a rectifier, a limiter with hysteresis, a clock extractor, a data extractor, a modulator and a logic section.

9. An apparatus as claimed in claim 8, in which the signal pickup means comprises a pickup coil.

10. A method of detecting the presence of tags within a target area by sending interrogation signals from a transceiver for selective modulation by tags present in the target area, each tag being allocated an identification word comprising a predetermined number of bits, the method comprising:

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sending from a transceiver an interrogation signal comprising a plurality of portions, each portion being associated with a predetermined bit or bit sequence of the identification words and being capable of conveying a given value for the bit or sequence of bits, wherein tags having the value at the predetermined bit or bit sequence are configured to modulate the signal, the modulation being used to identify the presence of those tags.

11. A method as claimed in claim 10, wherein the presence of a tag or tags having an individual identification word is detected by sending an interrogation signal having portions corresponding to all bits of the identification words.

12. A method as claimed in claim 10 or 11, wherein each portion comprises a first part which is used to interrogate the tags to determine whether the associated bit or sequence of bits has a first value, and a second part which is used to interrogate the tags to determine whether the associated bit or sequence of bits has a second value.

13. A method as claimed in claim 12, wherein if a portion is used to interrogate the tags to determine whether the associated bit or sequence of bits having the first value, the first part is sent, and if the portion is used to interrogate the tags to determine whether the associated bit or sequence of bits has a second value, the first and second parts are sent.

14. A method as claimed in claim 10 to 13, wherein a tag not having the value at the predetermined bit or bit sequence ignores further signals until an activation or a wake signal is received.

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15.   A method as claimed in any one of claims 10 to 14, wherein data bits of a tag transponder are read from and/or written to by sending further bits after the interrogation signal, wherein tag then deactivates and ignores further signals until an activation signal is received.

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16. A radio frequency tag identification system comprising a receiver/transmitter and transponders which are adapted to start communication at the same time and to be simultaneously interrogated and progressively eliminated from interrogation.

1/2

Start Search Pattern

Sequence gap

Modulation Window (MW-0)

Sequence Gap

Modulation Window (MW-0)

Sequence Gap

Modulation Window (MW-0)

A   B   C

Fig 1

Start Search Pattern

Sequence gap

Modulation Window (MW-0)

Sequence Gap

Modulation Window (MW-0)

Sequence Gap

Modulation Window (MW-0)

Modulation from Tag/s*

A   B   C

Fig. 2

Power
Regulator

DC Power

TUNING

Coil

RF Power
Generator

Micro-processor

Fig 4

Demodulator

Amplifier

communications
Interface

Modulator

Data
Extractor

Clock
Extractor

logic

Eeron

Fig 5

Reset

Coil

Rectifier

Power
Control

New Sweep Pattern

Sequence gap

Modulation Window (MW-0)

Sequence Gap

Modulation Window (MW-0)

Modulation Window (MW-1)

Sequence Gap

Modulation Window (MW-0)

Modulation from Tag/s*

A

B

C

Fig 3

*Note. The amount of modulation from tags is exaggerated. Typical modulation may be too small to be shown.

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G06K7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
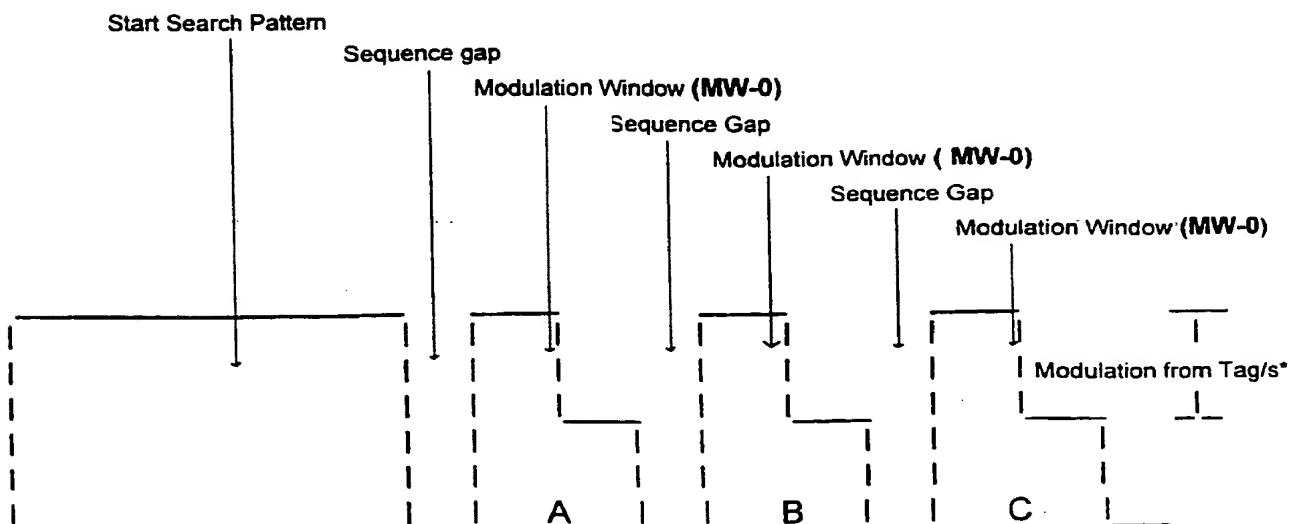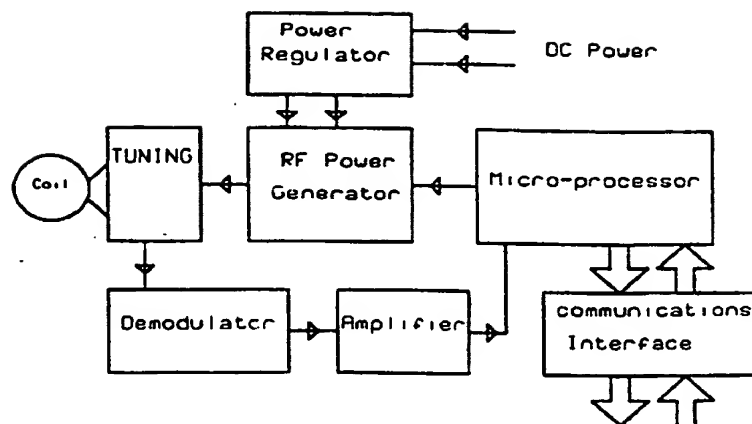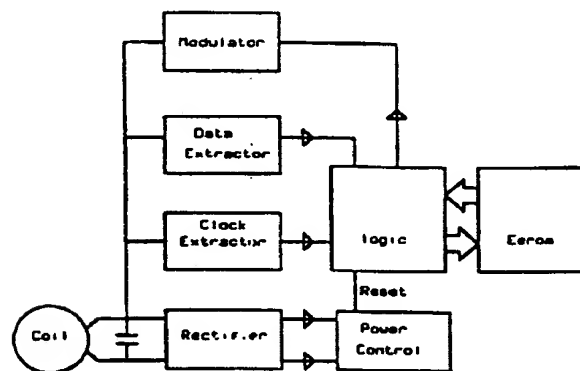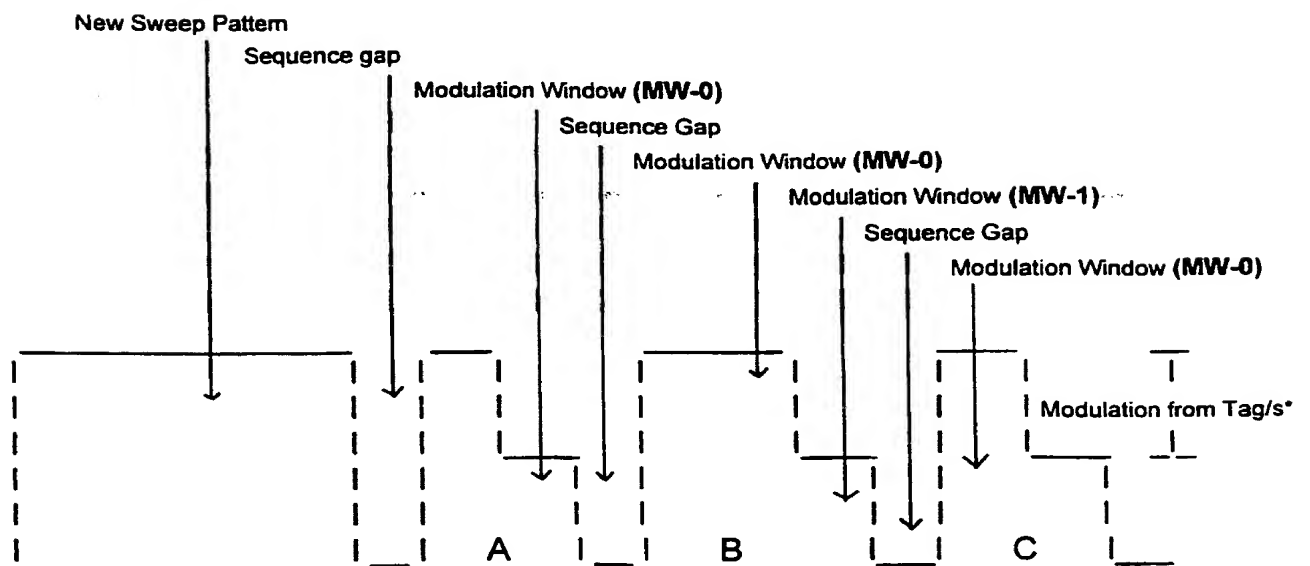
C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 702 324 A (IBM) 20 March 1996 (1996-03-20)	1-3,5, 10,11, 14-16
Y	column 4, line 18 –column 12, line 8; figures 1-6	8,9
A		12,13
Y	US 5 345 231 A (HOLWEG GERALD ET AL) 6 September 1994 (1994-09-06) the whole document	8,9
A	US 4 691 202 A (DENNE PHILLIP R M ET AL) 1 September 1987 (1987-09-01) column 4, line 1 –column 7, line 12; figures 1-5	14,15

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
1 October 1999	08/10/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Degraeve, A

INTERNATIONAL SEARCH REPORT

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 0702324	A	20-03-1996	US 5550547 A		27-08-1996
			JP 8094746 A		12-04-1996
			SG 33353 A		18-10-1996
US 5345231	A	06-09-1994	AT 395224 B		27-10-1992
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of the field or alternatively by use of complicated algorithms to decrypt overlay data.

These systems are typically hindered by more than one tag 'talking' at the same time.

5 In the past systems have attempted to decrypt overlaying data caused by multiple tags 'talking' at the same time or have relied on random transmissions to separate signals in the time domain or have used a field beam or conduct a time consuming binary search to isolate individual tags. Often tags need to be read twice or even 3 times to confirm there has been no data error.

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According to an aspect of the invention, there is provided a radio frequency tag apparatus comprising a plurality of tags and a transceiver for sending information to and receiveing information from the tags, wherein each tag is allocated an identification word comprising a predetermined number of bits, the tags comprising means for selectively modulating a

15 signal received from the transceiver, and the transceiver comprising means for sending an interrogation signal comprising a plurality of portions, wherein each portion is associated with a predetermined bit, or bit sequence, of the identification words and is used to interrogate, substantially at the same time, the tags to identify, in response to modulated signals provided by the tags, the presence of a tag or tags having a given value at the

20 predetermined bit or bit sequence.

According to another aspect of the present invention, there is provided a method of detecting the presence of tags within a target area by sending interrogation signals from a transceiver for selective modulation by tags present in the target area, each tag being allocated an

Claims

1. A radio frequency tag apparatus comprising a plurality of tags and a transceiver for sending information to and receiveing information from the tags, wherein each tag is allocated an identification word comprising a predetermined number of bits, the tags comprising means for selectively modulating a signal received from the transceiver, and the transceiver comprising means for sending an interrogation signal comprising a plurality of portions, wherein each portion is associated with a predetermined bit, or bit sequence, of the identification words and is used to interrogate, substantially at the same time, the tags to identify, in response to modulated signals provided by the tags, the presence of a tag or tags having a given value at the predetermined bit or bit sequence.

2. An apparatus as claimed in claim 1, further comprising, an antennae array, a radio frequency transponder, an external data communication port and an energising source.

3. An apparatus as claimed in 1 or 2 capable of generating modulated radio frequency power for application to the antennae.

4. An apparatus as claimed in any one of the preceding claims, including in each tag an inductive loop antennae or capacitor plates that will convert the electric power into an electric field to communicate with transponders and in some cases provide the power for transponders where this power is not derived internally within the transponder from internal batteries or a light cell.

5. An apparatus as claimed in any one of the preceding claims, including in each tag an antenna that will convert the signal power from the transceiver into an RF field to communicate with transponders.

6. An apparatus as claimed in any one of the preceding claims, including means for determining the nature of the modulation based on the logical outcome of previous communications with tags to conduct a binary search.

7. An apparatus as claimed in any one of the preceding claims, including means for detecting the modulation impressed on the field by any tag comprising a demodulator and an amplifier, wherein the modulation signal is sent to a processor in a logic block and is digitised within a logic processor and evaluated.

8. An apparatus as claimed in any one of the preceding claims, the tag or tags comprising of signal pickup means, a rectifier, a limiter with hysteresis, a clock extractor, a data extractor, a modulator and a logic section.

9. An apparatus as claimed in claim 8, in which the signal pickup means comprises a pickup coil.

10. A method of detecting the presence of tags within a target area by sending interrogation signals from a transceiver for selective modulation by tags present in the target area, each tag being allocated an identification word comprising a predetermined number of bits, the method comprising:

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sending from a transceiver an interrogation signal comprising a plurality of portions, each portion being associated with a predetermined bit or bit sequence of the identification words and being capable of conveying a given value for the bit or sequence of bits, wherein tags having the value at the predetermined bit or bit sequence are configured to modulate the signal, the modulation being used to identify the presence of those tags.

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11. A method as claimed in claim 10, wherein the presence of a tag or tags having an individual identification word is detected by sending an interrogation signal having portions corresponding to all bits of the identification words.

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12. A method as claimed in claim 10 or 11, wherein each portion comprises a first part which is used to interrogate the tags to determine whether the associated bit or sequence of bits has a first value, and a second part which is used to interrogate the tags to determine whether the associated bit or sequence of bits has a second value.

15

13. A method as claimed in claim 12, wherein if a portion is used to interrogate the tags to determine whether the associated bit or sequence of bits having the first value, the first part is sent, and if the portion is used to interrogate the tags to determine whether the associated bit or sequence of bits has a second value, the first and second parts are sent.

20

14. A method as claimed in claim 10 to 13, wherein a tag not having the value at the predetermined bit or bit sequence ignores further signals until an activation or a wake signal is received.

14

15. A method as claimed in any one of claims 10 to 14, wherein data bits of a tag transponder are read from and/or written to by sending further bits after the interrogation signal, wherein tag then deactivates and ignores further signals until an activation signal is received.

5

16. A radio frequency tag identification system comprising a receiver/transmitter and transponders which are adapted to start communication at the same time and to be simultaneously interrogated and progressively eliminated from interrogation.

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference NJE/G04380PC	**FOR FURTHER ACTION**	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/GB 99/01964	International filing date *(day/month/year)* 22/06/1999	(Earliest) Priority Date *(day/month/year)* 22/06/1998	

Applicant

POWELL, George, Leonard

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of _____2_____ sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

---

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable (See Box I).**

3. [ ] **Unity of Invention is lacking (see Box II).**

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.   3_____

   [X] as suggested by the applicant.   [ ] None of the figures.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   G06K7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6   G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category°	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 702 324 A (IBM) 20 March 1996 (1996-03-20)	1-3,5, 10,11, 14-16
Y	column 4, line 18 -column 12, line 8; figures 1-6	8,9
A		12,13
Y	US 5 345 231 A (HOLWEG GERALD ET AL) 6 September 1994 (1994-09-06) the whole document	8,9
A	US 4 691 202 A (DENNE PHILLIP R M ET AL) 1 September 1987 (1987-09-01) column 4, line 1 -column 7, line 12; figures 1-5	14,15

	Further documents are listed in the continuation of box C.	|X|	Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
1 October 1999	08/10/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Degraeve, A

Form PCT/ISA/210 (second sheet) (July 1992)

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 0702324	A	20-03-1996	US 5550547	A	27-08-1996
			JP 8094746	A	12-04-1996
			SG 33353	A	18-10-1996
US 5345231	A	06-09-1994	AT 395224	B	27-10-1992
			DE 59105094	D	11-05-1995
			EP 0473569	A	04-03-1992
			JP 2683305	B	26-11-1997
			JP 6152473	A	31-05-1994
US 4691202	A	01-09-1987	AT 65328	T	15-08-1991
			AU 572321	B	05-05-1988
			AU 4533485	A	29-01-1987
			EP 0161779	A	21-11-1985
			GB 2157132	A,B	16-10-1985
			JP 62046281	A	28-02-1987

PATENT COOPERATION TREATY COPIED FOR COMPUTE

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

ERTL, Nick
Elkington and Fife
Prospect House
8 Pembroke Road
Kent TN13 1XR
GRANDE BRETAGNE

RECEIVED

19 JUN 2000

E. & F. SEVENOAKS

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing *(day/month/year)*	15.06.2000

Applicant's or agent's file reference	
NJE/JME/G04380PC	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB99/01964	22/06/1999	22/06/1998

Applicant
POWELL, George, Leonard

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

    The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

    Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

    For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Schmethüsen, S Tel.+49 89 2399 2567 2875

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference NJE/JME/G04380PC	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/GB99/01964	International filing date *(day/month/year)* 22/06/1999	Priority date *(day/month/year)* 22/06/1998

International Patent Classification (IPC) or national classification and IPC G06K7/00

Applicant POWELL, George, Leonard

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

    ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

    These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

    I   ☒ Basis of the report
    II   ☐ Priority
    III   ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
    IV   ☐ Lack of unity of invention
    V   ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
    VI   ☐ Certain documents cited
    VII   ☒ Certain defects in the international application
    VIII ☒ Certain observations on the international application

Date of submission of the demand 16/12/1999	Date of completion of this report 15.06.2000
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Sucher, R Telephone No. +49 89 2399 2148

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. **PCT/GB99/01964**

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1,3-10	as originally filed			
2,2a	as received on	24/05/2000	with letter of	24/05/2000

Claims, No.:

1-16	as received on	24/05/2000	with letter of	24/05/2000

Drawings, sheets:

1/2,2/2	as originally filed

2. The amendments have resulted in the cancellation of:

☐ the description,   pages:

☐ the claims,   Nos.:

☐ the drawings,   sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 16.

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):

see separate sheet

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-15
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-15
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-15
	No:	Claims	

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

    see separate sheet

Re Item III
Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. Claim 16 does not meet the requirements of Article 6 PCT in that the matter for which protection is sought is not clearly defined. The claim attempts to define the subject-matter in terms of the result to be achieved which merely amounts to a statement of the underlying problem. The technical features necessary for achieving this result should have been added.

Re Item V
Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following document:

    D1: EP-A-0 702 324 (IBM) 20 March 1996.

2. It is clear from the description on pages 6-7 in conjunction with fig. 1 that the following feature is essential to the definition of the invention (see also claim 10):

    each portion of the interrogation signal is determined by the transceiver in dependence on the modulation response from the tags to the previous portion.

    Since independent claim 1 does not contain this feature it does not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.

3. In contrast to the identification system described in D1 wherein, if more than one tag tries to respond to the base station, the base station transceiver sends a fail command which causes the tags to retransmit the identification information depending on an internal state counter until only one tag remains (see col. 7, l. 27 - col. 8, l. 15), claim 1 - when clarified as above - solves the problem of identifying

a tag by determining in the base station transceiver the modulation of the interrogation signal by the tags (as it is defined in the description) based on the logical outcome of previous communications with tags to conduct a binary search. Since this alternative solution is not suggested by any prior art document, the subject-matter of claim 1 appears to involve an inventive step (Article 33(3) PCT).

4.   Claim 10 only comprises method features corresponding to the function of the apparatus features according to claim 1. Consequently, the statement made with respect to claim 1 is also valid for claim 10.

5.   Claims 2-9 and 11-15 are dependent on claims 1 and 10, respectively, and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Re Item VIII
Certain observations on the international application

1.   The term "without corruption" used in claims 1 and 10 is vague and indefinite and leaves the reader in doubt as to the meaning of the technical feature to which it refers, thereby rendering the definition of the subject-matter of said claims unclear (Article 6 PCT).

     Further, the meaning of "modulating a signal" which is used in claims 1 and 10 and describes an essential part of the invention is not clearly defined.

     Finally, the terms "tag" and "transponder", which appear to describe the same device, are inconsistently used throughout the claims.

2.   see item V, par. 2.

Re Item VII
Certain defects in the international application

1.   Independent claims 1 and 10 are not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features

known in combination from the prior art (document D1) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

2

of the field or alternatively by use of complicated algorithms to decrypt overlay data.

These systems are typically hindered by more than one tag 'talking' at the same time.

5   In the past systems have attempted to decrypt overlaying data caused by multiple tags 'talking' at

the same time or have relied on random transmissions to separate signals in the time domain or

have used a field beam or conduct a time consuming binary search to isolate individual tags.

Often tags need to be read twice or even 3 times to confirm there has been no data error.

10   Such a system is disclosed in European patent application number 95112673.9. A tree splitting

algorithm is used to identify a tag in a field. Where all tags respond simultaneously, they

interfere with each others transmission and the base station receives corrupted data. The tree

splitting algorithm organizes and sequences the transmission from tags via a random number

generator so that the base station receives data in an orderly manner that is not superimposed and

15   therefore corrupted.

According to an aspect of the invention, there is provided a radio frequency tag apparatus

comprising a plurality of tags and a transceiver for sending information to, and simultaneously

receiving information from, a plurality of tags without corruption, wherein each tag is allocated

20   an identification word comprising a predetermined number of bits, the tags comprising means for

selectively modulating a signal received from the transceiver, and the transceiver comprising

means for sending an interrogation signal comprising a plurality of portions, wherein each

portion is associated with a predetermined bit, or bit sequence, of the identification words

AMENDED SHEET

2a

used to simultaneously interrogate, substantially at the same time, the tags to identify, in response

to modulated signals provided by the tags, the presence of a tag or tags having a given value at

the predetermined bit or bit sequence.

5   According to another aspect of the present invention, there is provided a method of detecting the

presence of tags within a target area by sending interrogation signals from a transceiver for

selective simultaneous modulation by tags present in the target area, each tag being allocated an

AMENDED SHEET

REV. VON: EPA MUENCHEN 06   :24- 5- 0 :   10:42 :   01732450346-   +49 89 ????????

24-05-2000   GB 009901964

11

Claims

1. A radio frequency tag identification system comprising a plurality of tags and a transceiver for sending information to and simultaneously receiving information from a

5   plurality of tags without corruption, wherein each tag is allocated an identification word comprising a predetermined number of bits, the tags comprising means for selectively modulating a signal received from the transceiver, and the transceiver comprising means for sending an interrogation signal comprising a plurality of portions, wherein each portion is associated with a predetermined bit, or bit sequence, of the identification words

10 and is used to simultaneously interrogate tags and simultaneously receive information from tags to identify, in response to modulated signals provided by the tags, the presence of a tag or tags having a given value at the bit or bit sequence.

2. A system as claimed in claim 1, the transceiver further comprising, an antennae array,

15 a radio frequency transponder, an external data communication port and an energizing source.

3. A system as claimed in claim 2, the transceiver being capable of generating modulated radio frequency power for application to the antennae.

20

4. A system as claimed in any one of the preceding claims, including in each tag an inductive loop antennae or capacitor plates that will convert the electric power into an electric field to communicate with transponders and provide the power for transponders where this power is not derived internally within the transponder from internal batteries

25 or a light cell.

5. A system as claimed in any one of the preceding claims, including in each tag an antenna that will convert the signal power from the transceiver into an RF field to communicate with transponders.

30

AMENDED SHEET

12

6. A system as claimed in any one of the preceding claims, the transceiver including means for determining the nature of the modulation based on the logical outcome of previous communications with tags to conduct a binary search.

5   7. A system as claimed in any one of the preceding claims, the transceiver including means for detecting the modulation impressed on the field by any tag or plurality of tags in simultaneous communication, without corruption, comprising a demodulator and an amplifier, wherein the modulation signal is sent to a processor in a logic block and is digitized within a logic processor and evaluated.

10

8. A system as claimed in any one of the preceding claims, the tag or tags comprising signal pickup means, a rectifier, a limiter with hysteresis, a clock extractor, a data extractor, a modulator and a logic section.

15 . 9. A system as claimed in claim 8, in which the signal pickup means comprises a pickup coil.

10. A method of detecting the presence of tags within a target area by sending interrogation signals from a transceiver for selective simultaneous modulation by active

20   tags present in the target area, each tag being allocated an identification word comprising a predetermined number of bits, the method comprising:
 sending from a transceiver an interrogation signal comprising a plurality of portions, each portion being associated with predetermined bit or bit sequence of the identification words and being capable of conveying a given value for the bit or sequence of bits, each

25   portion being determined by the transceiver in dependence on the modulation response to the previous portion, wherein all tags in the field having the value at the predetermined bit or bit sequence are configured to simultaneously modulate the signal, the modulation being used to identify the presence of those tags.

AMENDED SHEET

13

11. A method as claimed in claim 10, wherein the presence of a tag or tags having an individual identification word is detected by sending an interrogation signal having portions and corresponding to all bits of the identification words.

5   12. A method as claimed in claim 10 or 11, using an adaptive interrogation signal wherein each portion comprises a first part which is used to simultaneously interrogate all active tags to determine whether the associated bit or sequence of bits has a first value, and a second part which is determined in dependence on the simultaneous response of the active tags in the field to interrogate the tags to determine whether the associated bit or

10   sequence of bits has a second value.

13. A method as claimed in claim 12, wherein if a portion is used to interrogate the tags to determine whether the associated bit or sequence of bits having the first value, the first part is sent, and if the portion is used to interrogate the tags to determine whether the

15   associated bit or sequence of bits has a second value, the first and second parts are sent.

14. A method as claimed in claim 10 to 13, wherein a tag not having the value at the predetermined bit or bit sequence ignores further signals until an activation or a wake signal is received.

20

15. A method as claimed in any one of claims 10 to 14, wherein data bits of a tag transponder are read from and/or written to by sending further bits after the interrogation signal, wherein tag then deactivates and ignores further signals until an activation signal is received.

25

16. A method whereby a tag can determine if the reader transceiver has received its attempted communication based on subsequent interrogation signals.

AMENDED SHEET

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference NJE/G04380PC /	**FOR FURTHER ACTION**	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/GB 99/ 01964	International filing date *(day/month/year)* 22/06/1999	(Earliest) Priority Date *(day/month/year)* 22/06/1998

Applicant POWELL, George, Leonard

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of _____2_____ sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

    a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

    [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

    b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

    [ ] contained in the international application in written form.

    [ ] filed together with the international application in computer readable form.

    [ ] furnished subsequently to this Authority in written form.

    [ ] furnished subsequently to this Authority in computer readble form.

    [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

    [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable (See Box I).**

3. [ ] **Unity of invention is lacking (see Box II).**

4. With regard to the **title,**

    [X] the text is approved as submitted by the applicant.

    [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

    [X] the text is approved as submitted by the applicant.

    [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.   3

    [X] as suggested by the applicant.   [ ] None of the figures.

    [ ] because the applicant failed to suggest a figure.

    [ ] because this figure better characterizes the invention.

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6   G06K7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6   G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched .

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category°	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 702 324 A (IBM) 20 March 1996 (1996-03-20)	1-3,5, 10,11, 14-16
Y	column 4, line 18 -column 12, line 8; figures 1-6	8,9
A	—	12,13
Y	US 5 345 231 A (HOLWEG GERALD ET AL) 6 September 1994 (1994-09-06) the whole document	8,9
A	US 4 691 202 A (DENNE PHILLIP R M ET AL) 1 September 1987 (1987-09-01) column 4, line 1 -column 7, line 12; figures 1-5	14,15

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

Date of the actual completion of the International search	Date of mailing of the International search report
1 October 1999	08/10/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Degraeve, A

3

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 99/01964

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 0702324	A	20-03-1996	US 5550547	A	27-08-1996
			JP 8094746	A	12-04-1996
			SG 33353	A	18-10-1996
US 5345231	A	06-09-1994	AT 395224	B	27-10-1992
			DE 59105094	D	11-05-1995
			EP 0473569	A	04-03-1992
			JP 2683305	B	26-11-1997
			JP 6152473	A	31-05-1994
US 4691202	A	01-09-1987	AT 65328	T	15-08-1991
			AU 572321	B	05-05-1988
			AU 4533485	A	29-01-1987
			EP 0161779	A	21-11-1985
			GB 2157132	A,B	16-10-1985
			JP 62046281	A	28-02-1987